

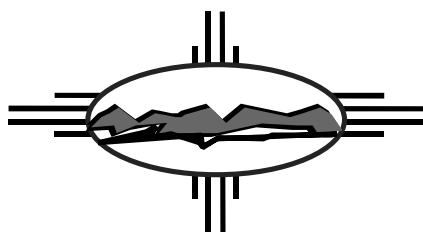
## STANDARD OPERATING PROCEDURE

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# ER PROJECT

### APPROVALS FOR USE

Author's Name (Print):

**Jennifer Pope**

Author's Signature:

Date:

**03/08/99**

Quality Program Project Leader's Name (Print)

**Larry Maassen**

Quality Program Project Leader's Signature

Date:

**03/08/99**

*LOS ALAMOS NATIONAL LABORATORY*

# Aquifer pumping Tests

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# Aquifer Pumping Tests

**NOTE:** Environmental Restoration (ER) Project personnel may produce paper copies of this procedure printed from the controlled document electronic file. However, it is their responsibility to ensure that they are trained on and utilizing the current version of this procedure. The procedure author may be contacted if text is unclear.

## 1.0 PURPOSE

This Standard Operating Procedure (SOP) states the methods for conducting pumping tests for the determination of the hydraulic properties of water-bearing soils and rocks for the ER Project.

## 2.0 TRAINING

The **Field Team Leader** (FTL) is responsible for ensuring that field team members who perform pumping tests for the ER Project are properly trained. In addition, all field team members who use this procedure shall be familiar with the objectives of pumping tests and must document that they have read and understand this procedure in accordance with QP-2.2.

## 3.0 DEFINITIONS

- 3.1 Transmissivity — The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient expressed in gallons per day per foot (gpd/ft).
- 3.2 Hydraulic conductivity — The rate of fluid flow in gallons per day through a cross section of one square foot (gpd/ft<sup>2</sup>) of a permeable medium under a unit hydraulic gradient at the prevailing temperature or at 16°C. It is a function of both the media and of the fluid flowing through it. Also known as the coefficient of permeability or Meinzer unit.
- 3.3 Site-Specific Health and Safety Plan (SSHASP)—A health and safety plan that is specific to a site or ER-related field activity that has been approved by an ER health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

- 3.4 Specific yield — The ratio of the volume of water that a given mass of saturated rock or soil will yield by gravity to the volume of the mass expressed as a percentage (dimensionless).
- 3.5 Storage coefficient — The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head (dimensionless).

## 4.0 BACKGROUND AND PRECAUTIONS

**Note:** This SOP is to be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

- 4.1 An aquifer pumping test is a controlled field experiment to determine the hydraulic properties of water-bearing soils and rocks. Aquifer characteristics that may be obtained from pumping tests include hydraulic conductivity (K), transmissivity (T), specific yield (Sy) for unconfined aquifers, the storage coefficient (S) for confined aquifers, and the vertical hydraulic conductivity of confining layers. Also, the occurrence and position of recharge or impermeable boundaries can be identified. These parameters can be determined by graphical solutions and computerized programs.
- 4.2 Pumping tests are generally carried out by monitoring the water level over time in the pumping well and in each observation well while the pumping well is being discharged at a constant rate. This test provides results that are more representative of aquifer characteristics than those predicted by other methods. They can also be used to determine the hydraulics of secondary aquifer flow. However, pump tests require a greater degree of activity and expense than other methods and therefore may not always be justified for all levels of investigation.
- 4.3 Refer to the site-specific work plan for the duration of the pumping test, the location of the observation well, and the data to be collected. Collection of measurements and documentation of data will be performed as described in the associated procedures.

## 5.0 EQUIPMENT

A checklist of suggested equipment and supplies employed to implement this procedure is provided in Attachment A.

## 6.0 PROCEDURE

**Note:** Deviations from SOPs are made in accordance with QP-4.2.

- 6.1 Ensure that permission to discharge is obtained (an NPDES Permit may be required) or that a containment system is available for collecting the water that will be pumped during the test. This is especially important for wells that may produce contaminated water. Consult ER-SOP-1.06 in the event that the site-specific work plan requires containerization of waste.
- 6.2 Obtain the pumping test equipment, their manufacturers' operating manuals, and information on equipment modifications necessary to conduct a pumping test. Check the equipment for proper functioning. Confirm from the site drilling crew that well installation is complete and that the equipment necessary to conduct the pumping test is deployed. The drilling crew is responsible for completing the following tasks and supplying the equipment listed below before field personnel arrive.
  - 6.2.1 Drilling, installing, completing, and developing pumping wells and at least one observation well to the proper specifications identified in the site-specific work plan.
  - 6.2.2 Installing a submersible or turbine pump. All wells should be properly developed before testing.
  - 6.2.3 Installing a flow meter in the discharge line of the pumping well to accurately measure and monitor the volume of discharge.
  - 6.2.4 Installing sufficient pipe to transport the discharge from the pumping well away from the area to prevent infiltration of extracted water into the pumped zone.
  - 6.2.5 Installing a gate valve along with a pressure regulator on the discharge pipe to control the pumping rate.
  - 6.2.6 Placing an outlet near the well head, but past the totalizer and flow meters, for water-quality determination and sampling.
- 6.3 Ensure that all gauges, transducers, flow meters, and other equipment used in conducting pumping tests are properly calibrated before use, in accordance with QP 5.2. Obtain copies of the instrumentation documentation and calibration. File them with the records of test data. Calibration records should contain laboratory measurements. If necessary, perform any on-site zero adjustment or calibration.
- 6.4 It is normally advisable to monitor and record pretest water levels at the test site for about one week before performing the test. This can be accomplished by using a continuous recording device. These records

establish the barometric efficiency of the aquifer. The records also help determine if the aquifer is experiencing an increase or decrease in head over time that may be caused by recharge or pumping in the nearby area or by diurnal variations.

- 6.5 Record changes in barometric pressure during the test (preferably with an on-site barograph) to correct water level readings for any possible fluctuations that may occur from changing atmospheric conditions. Project the pretest water level trends for the duration of the test. These trends or barometric changes may be used to correct water level measurements during the test so that they are representative of the hydraulic response of the aquifer from pumping the test well.
- 6.6 The duration of the test is determined by the needs of the project and the aquifer properties. In general, longer tests produce more definitive results. A duration of one to several days, followed by a similar period of monitoring the recovery of the water level, is desirable.
  - 6.6.1 There is no need to continue the test if the water level becomes constant with time. This normally indicates that a hydrogeologic source or leaky aquifer condition has been intercepted and that additional useful information will not be collected by continued pumping.
  - 6.6.2 One simple test for determining the adequacy of data is to plot the log time compared to drawdown for the most distant observation well. When the plot becomes a straight line on the semilog graph paper, enough data has been collected. (Ideally the straight line should continue over one log cycle.)
- 6.7 When an electronic data logger and pressure transducer are used to perform the pumping test, store all data internally or on computer diskettes or tape. Transfer the information directly to the main computer to analyze it. Periodically determine measurements manually to verify the data recorded by the data logger.
- 6.8 If an electronic data logger and pressure transducer are not used, record all data on the Pumping/Recovery Test Data form (Attachment B). Data collected manually during a logger-transducer pumping test will also be recorded on the form. Fill out the form as described in the completion instructions provided after the form in Attachment B.
- 6.9 During a pumping test, measure water levels as often as necessary to produce a meaningful indication of hydraulic properties of the aquifer. Measure water levels as specified in ER-SOP-7.02.

**Note:** Pressure transducers and electronic data loggers may be used to reduce the field personnel hours required for the pumping test.

Please refer to ER-SOP-7.01 for the operating instructions for pressure transducers.

- 6.10 After the pumping test is concluded, measure recovering water levels to verify the results obtained from the pumping portion of the test. Measure the recovering water levels in the pumping well and the observation wells for a period immediately following the cessation of pumping. Monitoring during recovery should occur for at least half the length of the pumping portion of the aquifer test. The decision to cease monitoring water levels will be based on aquifer recovery.
- 6.11 If using an electronic data logger, follow the steps listed below:
  - 6.11.1 Stop the logging sequence.
  - 6.11.2 Print the data or send it to the computer by telephone.
  - 6.11.3 Save memory and disconnect the battery at the end of the day's activities.
- 6.12 Decontaminate the transducer(s) and cable(s) as specified in ER-SOP-1.08.
- 6.13 Make sure all wells are properly labeled and the location ID is readily visible on the guard pipe.

## **7.0 REFERENCES**

The following documents have been cited within this procedure.

- QP-2.2, Personnel Orientation and Training
- QP-4.2, Standard Operating Procedure Development
- QP-4.3, Records Management
- QP 5.2, Control of Measuring and Test Equipment
- ER-SOP-1.04, Sample Control and Field Documentation
- ER-SOP-1.06, Management Environmental Restoration Project Wastes
- ER-SOP-1.08, Field Decontamination of Drilling and Sampling Equipment
- ER-SOP-7.01, Pressure Transducers
- ER-SOP-7.02, Fluid Level Measurements

## **8.0 RECORDS**

The **FTL** is responsible for submitting the following records (processed in accordance with QP-4.3) to the Records Processing Facility.

- 8.1 A completed Pumping/Recovery Test Data form.
- 8.2 A completed Groundwater Elevation form (Attachment B in ER-SOP-7.02).
- 8.3 Completed Daily Activity Log forms or field notebook containing deviations, calibration data, and all other pertinent information.

## **9.0 ATTACHMENTS**

The document user may employ documentation formats different from those attached to/named in this procedure—as long as the substituted formats in use provide, as a minimum, the information required in the official forms developed by the procedure.

Attachment A: Equipment and Supplies Checklist for Aquifer Pumping Tests (1 page)

Attachment B: Pumping/Recovery Test Data (form and completion instructions) (3 pages)



## Equipment and Supplies Checklist for Aquifer Pumping Tests

- \_\_\_\_\_ Water pressure transducer
- \_\_\_\_\_ Electric water level indicator
- \_\_\_\_\_ Weighted tapes with plover
- \_\_\_\_\_ Steel tape (subdivided into tenths of feet)
- \_\_\_\_\_ Electronic data logger (if transducer method is used)
- \_\_\_\_\_ Tape measure (subdivided into hundredths of feet)
- \_\_\_\_\_ Watch or stopwatch with second hand
- \_\_\_\_\_ Semilog graph paper (if required)
- \_\_\_\_\_ Waterproof-ink pen
- \_\_\_\_\_ Thermometer
- \_\_\_\_\_ Appropriate references and calculator
- \_\_\_\_\_ Barometer or recording barograph (for tests conducted in confined aquifers)
- \_\_\_\_\_ Daily Activity Log forms
- \_\_\_\_\_ Pumping/Recovery Test Data forms
- \_\_\_\_\_ Groundwater Elevation forms
- \_\_\_\_\_ Any PPE listed or required in the SSHASP
- \_\_\_\_\_ Any additional supplies listed in associated procedures, as needed
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ER-SOP-7.04

Los Alamos  
Environmental Restoration Project

<b>Pumping/Recovery Test Data</b>				
Date/Time _____		Sheet ____ of ____		
Technical Area _____		Operable Unit _____		Pump Well Number _____
Site Work Plan _____		Observation Well Number _____		
Field Team Member Signature _____		Distance from Pumped Well (ft) _____		
(Print name and title, then sign)				
Test Start:		Test End:		
Date _____		Date _____		
Time _____		Time _____		
Static Water Level (ft) _____		Static Water Level (ft) _____		
Average Pumping Rate (gal./min) _____				
Measurement Instruments _____				
Comments _____				
Method of Water Level Measurement _____				
Drawdown Test			Recovery Test	
Elapsed Time (minutes)	Depth to Water (feet)	Pumping Rate (gal./min)	Elapsed Time (minutes)	Depth to Water (feet)
ER-SOP-7.04			<b>Los Alamos</b> <b>Environmental Restoration Project</b>	

## **Completion Instructions for the Pumping/Recovery Test Data Form**

Use an indelible dark-ink pen. Make an entry in each blank. For entry blanks for which no data are obtained (except in Comments section), enter “UNK” for unknown, “N/A” for not applicable, or “ND” for not done, as appropriate. To change an entry, draw a single line through it, add the correct information above it, and date and initial the change. For all forms, complete the following information:

### **Header Information:**

1. Date/Time—The date and time when the measurement was made, in the following formats: DD-MMM-YY (e.g., 01-JAN-91) and the 24-hr clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.).
2. Sheet Number—Number all the sheets that are used for this activity, by day or by some practical unit.
3. Technical Area (TA)—Two-digit number which indicates the TA in which the activity is being performed.
4. Operable Unit—Four-digit number indicating the Operable Unit in which the sampling is being done or sample is being studied.
5. Site Work Plan—Title of plan.
6. Distance From Pumped Well (ft)—Distance the observation well is from the pumping well in feet and tenths of feet.
7. Field Team Member Identification—Print your name and position title, then sign.

Weather and Other Comments. Record all other conditions pertinent to the sample collection in this section on the Daily Activity Log form in ER-SOP-1.04.

### **Testing Parameters:**

1. Test Start Date—The date when pumping began.
2. Test Start Time—The time when pumping began.
3. Static Water Level (ft)—Depth to water’s surface in feet and hundredths of feet in the observation well at the beginning of the pumping test.
4. Test End Date—The date when pumping ceased.
5. Test End Time—The time when pumping ceased.
6. Static Water Level (ft)—Depth to water’s surface in feet and hundredths of feet in the observation well at the end of the pumping test.

7. Average Pumping Rate (gal./min)—Total volume pumped (from totalizer meter) divided by the total elapsed time.
8. Measurement Instruments—Type of instrument used to measure depth to water's surface (may include steel tape, electric sounding probes, Stevens recorders, level heads, or pressure transducers).
9. Comments—Any additional information.
10. Method of Water Level Measurement—Note method used from ER-SOP-7.02.

### Drawdown Test

1. Elapsed Time (min)—Time of measurement recorded continuously from time 0.00 (start of test) in minutes.
2. Depth to Water (ft)—Depth to water's surface in feet and hundredths of feet in the pump or observation well at the time of the water level measurement.
3. Pumping Rate (gal./min)—Flow rate in gallons per minute of pumping measured from the in-line flow meter. This column should be completed only for the form used with the pumped well.

### Recovery Test

1. Elapsed Time (min)—Time of measurement recorded continuously from time 0.00 (start of test) in minutes.
2. Depth to Water (ft)—Depth to water's surface in feet and hundredths of feet in the pump or observation well at the time of the water level measurement.